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ARKABUTLA RESERVOIR, DESOTO AND TATE COUNTIES, MISSISSIPPI

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

PREPARED FOR
NATIONAL ENVIRONMENTAL RESEARCH CENTER

JUNE 1975

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

ARKABUTLA RESERVOIR

DESOTO AND TATE COUNTIES

MISSISSIPPI

EPA REGION IV

WORKING PAPER No. 359

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

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and

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REPORT
ON
ARKABUTLA RESERVOIR
DESOTO AND TATE COUNTIES
MISSISSIPPI
EPA REGION IV
WORKING PAPER No. 359

WITH THE COOPERATION OF THE
MISSISSIPPI AIR AND WATER POLLUTION
CONTROL COMMISSION
AND THE
MISSISSIPPI NATIONAL GUARD

JUNE, 1975

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

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CONTENTS

	Page
Foreword	ii
List of Mississippi Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	8
V. Literature Reviewed	14
VI. Appendices	15

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [303(e)], water quality criteria/standards review [303(c)], clean lakes [314(a,b)], and water quality monitoring [106 and 305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Mississippi Air and Water Pollution Control Commission for professional involvement and to the Mississippi National Guard for conducting the tributary sampling phase of the Survey.

Glen Wood, Jr., Director, and John Smith, Deputy Director of the Air and Water Pollution Control Commission; and John Harper, Don Scott, John Sigman, and Dwight White of the Water Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

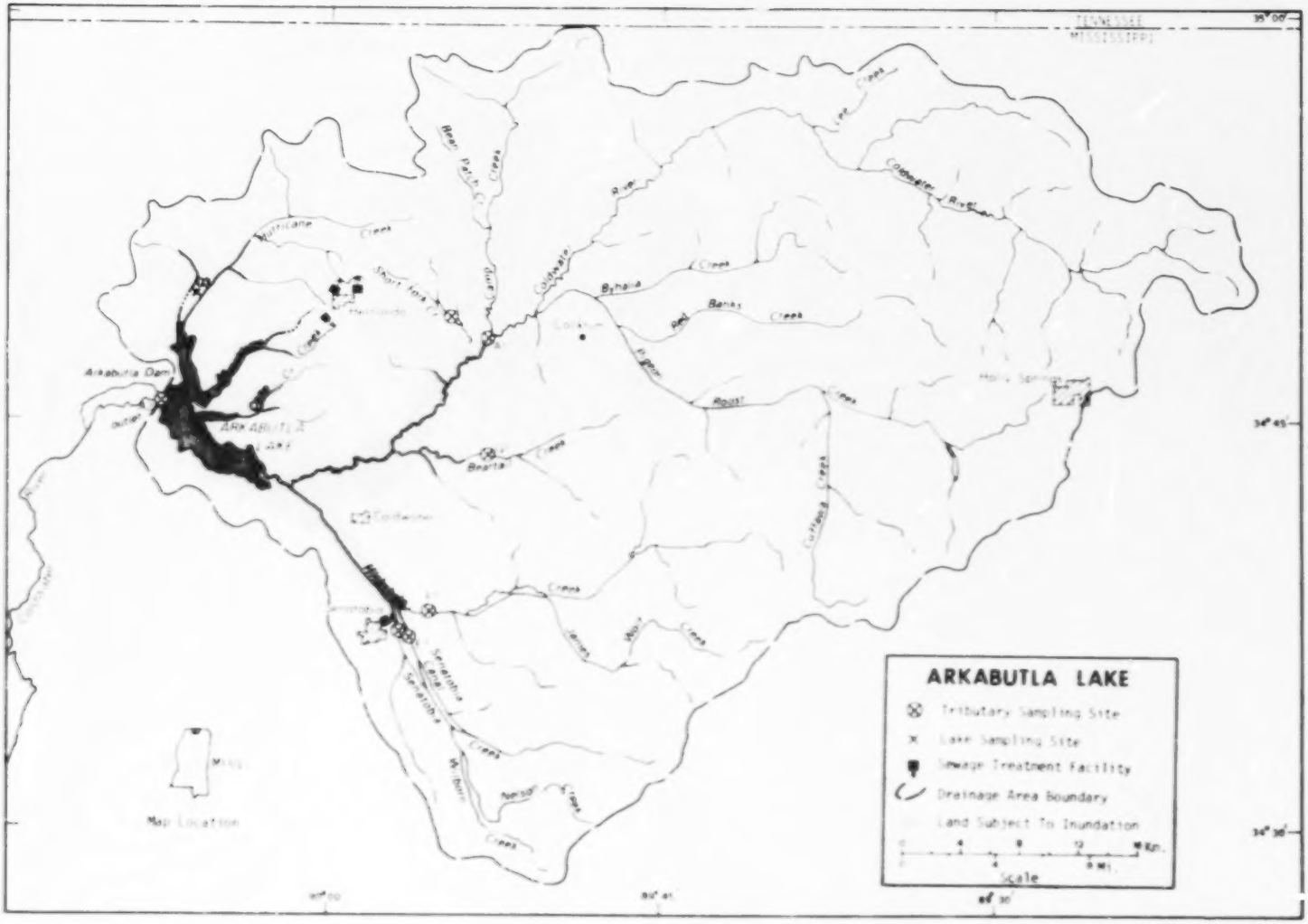
Major General E. A. Boby Turnage, the Adjutant General of Mississippi, and Project Officer Major Thomas D. Nichols, who directed the volunteer efforts of the Mississippi National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MISSISSIPPI

LAKE NAME	COUNTY
Arkabutla	DeSoto, Tate
Enid	Yalobusha
Grenada	Calhoun, Grenada, Yalobusha
Pickwick	Tishominga
Ross Barnett	Jackson, Madison, Rankin
Sardis	Lafayette, Panola


ARKABUTLA LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
Land Subject To Inundation
Scale
Map Location
Arkabutla Dam
ARKABUTLA LAKE
Coldwater River
Coldwater
Byhalia Creek
Red Banks Creek
Pigeon Roost Creek
Cuttawa Creek
Bear Patch Cr.
Hurricane Creek
Short Fork Cr.
Bearta Creek
Senatobia Creek
Wilborn Creek
Nelson Creek
Lee Creek
Holly Springs
Hernando
Lockum
Senatobia Canal
Mills
35° 00'
34° 45'
34° 30'
90° 00'
89° 45'
89° 30'

ARKABUTLA RESERVOIR

STORET NO. 2801

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Arkabutla Reservoir is eutrophic. Of the five water bodies sampled in Mississippi in 1973, Arkabutla ranked last using a combination of six parameters as an index to overall trophic quality*. Arkabutla Reservoir had the highest median total and dissolved phosphorus, the highest median inorganic nitrogen, the least mean Secchi disc transparency, but two of the other water bodies had greater mean chlorophyll a. Depletion or near-depletion of dissolved oxygen with depth occurred at all three sampling stations in June, and marked depression occurred in August.

Survey limnologists noted aquatic macrophytes near stations 2 and 3 in August.

B. Rate-Limiting Nutrient:

Because of a significant loss of nitrogen in the sample, the results of the algal assay are not representative of conditions in the reservoir at the time the sample was taken (06/13/73).

The reservoir data indicate phosphorus limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--The phosphorus load from the known

* See Appendix A.

point sources amounted to 12.2% of the total reaching the reservoir during the sampling year.

Even with complete phosphorus removal at the point sources, the loading would still be double that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). However, since the reservoir is phosphorus limited, any decrease in the phosphorus loading would be expected to result in at least some improvement in the trophic condition.

2. Non-point sources--The phosphorus load from non-point sources amounted to 87.8% of the total reaching the reservoir during the sampling year. The gaged tributaries contributed 77.3% of the total and ranged from 49.3% (Coldwater River) to 1.8% (Short Fork Creek). The minor tributaries and immediate drainage were estimated to have contributed 9.9% of the total.

The phosphorus export rates of most of the reservoir tributaries (page 12) were somewhat higher than the rates of the tributaries of nearby Sardis Lake* (mean=18 kg/km^2/year; range of 5 to 38 kg/km^2/year). However, since all known point sources were accounted for, it is likely that the higher rates of Arkabutla Reservoir tributaries were the result of differences in land-use practices in the two drainages.

* Working Paper No. 363.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 48.04 kilometers^2.
2. Mean depth: 9.1 meters.
3. Maximum depth: 14.7 meters.
4. Volume: 437.101 x 10^6 m^3.
5. Mean hydraulic retention time: 108 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Coldwater River	1,364.9	23.7
Short Fork Creek	40.1	0.6
Senatobia Creek	46.1	0.6
Senatobia Canal	123.3	2.8
Hickahala Creek	598.3	9.6
Beartail Creek	119.9	2.0
Minor tributaries & immediate drainage -	249.4	7.5
Totals	2,542.0	46.8

2. Outlet -

Coldwater River	2,590.0**	46.8**

C. Precipitation***:

1. Year of sampling: 147.0 centimeters.
2. Mean annual: 137.1 centimeters.

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† Table of metric conversions--Appendix B.
†† Smith, 1973.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Arkabutla Reservoir was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the reservoir and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 11.0 meters at station 1, 11.9 meters at station 2, and 6.4 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR ARKABUTLA LAKE
STORET CODE 2801

PARAMETER	1ST SAMPLING (6/13/73) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/28/73) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (11/ 1/73) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	18.9 - 30.6	23.4	22.1	24.2 - 29.6	27.8	28.4	14.4 - 16.0	15.3	15.9
DISS OXY (MG/L)	0.0 - 6.0	2.6	1.8	0.2 - 5.4	3.3	3.6	8.4 - 9.4	8.9	8.8
CNDCTVY (MCROMO)	46. - 100.	63.	56.	70. - 121.	78.	71.	51. - 53.	52.	52.
PH (STAND UNITS)	6.7 - 8.3	7.4	7.1	6.4 - 7.1	6.7	6.6	7.7 - 7.9	7.8	7.8
TOT ALK (MG/L)	12. - 26.	18.	18.	24. - 40.	27.	26.	19. - 20.	19.	19.
TOT P (MG/L)	0.166 - 0.334	0.243	0.232	0.048 - 0.110	0.065	0.058	0.046 - 0.411	0.199	0.175
ORTHO P (MG/L)	0.015 - 0.036	0.025	0.025	0.006 - 0.011	0.009	0.009	0.025 - 0.034	0.030	0.031
NO2+NO3 (MG/L)	0.140 - 0.500	0.324	0.350	0.040 - 0.110	0.077	0.070	0.210 - 0.340	0.289	0.300
AMMONIA (MG/L)	0.140 - 0.660	0.259	0.205	0.050 - 0.810	0.179	0.090	0.080 - 0.160	0.116	0.110
KJEL N (MG/L)	0.400 - 1.200	0.736	0.650	0.800 - 1.900	1.156	1.100	0.500 - 0.900	0.687	0.650
INORG N (MG/L)	0.440 - 0.820	0.589	0.575	0.090 - 0.910	0.256	0.190	0.290 - 0.450	0.405	0.430
TOTAL N (MG/L)	0.700 - 1.480	1.065	1.020	0.850 - 2.000	1.232	1.170	0.830 - 1.150	0.976	0.980
CHLRPYL A (UG/L)	2.7 - 7.3	4.3	2.9	4.1 - 6.0	4.9	4.5	5.2 - 15.8	10.3	10.0
SECCHI (METERS)	0.2 - 0.3	0.2	0.3	0.5 - 0.8	0.6	0.7	0.2 - 0.3	0.3	0.3

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
06/13/73	1. *Melosira sp.*	276
	2. Blue-green filaments	232
	3. *Euglena sp.*	116
	4. Flagellates	102
	5. *Trachelomonas sp.*	58
	Other genera	115
	Total	899
08/28/73	1. *Melosira sp.*	709
	2. *Trachelomonas sp.*	126
	3. *Cryptomonas sp.*	76
	4. *Gymnodinium sp.*	76
	5. *Cyclotella sp.*	76
	Other genera	151
	Total	1,214
11/01/73	1. *Dactylococcopsis sp.*	152
	2. *Mallomonas sp.*	84
	3. *Cryptomonas sp.*	84
	4. *Melosira sp.*	67
	5. Centric diatoms	67
	Other genera	153
	Total	607

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
06/13/73	01	7.3
	02	2.9
	03	2.7
08/28/73	01	4.1
	02	4.5
	03	6.0
11/01/73	01	10.0
	02	5.2
	03	15.8

C. Limiting Nutrient Study:

A 39% loss of inorganic nitrogen occurred in the assay sample between the time of collection and the beginning of the assay, and the results are not indicative of conditions in the reservoir at the time the sample was collected. However, the reservoir data indicate phosphorus limitation at all sampling times; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 14/1 or greater, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Mississippi National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of October when two samples were collected. Sampling was begun in August, 1973, and was completed in June, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Mississippi District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2, C-1, D-1, E-1, F-1, and G-1 and multiplying the means by the ZZ area in km^2.

The operators of the Hernando wastewater treatment plants provided monthly effluent samples and corresponding flow data. The communities of Senatobia and Coldwater did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

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* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Hernando "A"	2,000	lagoon	1,223.9	Massacuna Creek
Hernando "B"	250	lagoon	427.8	Hurricane Creek
Hernando "C"	200	lagoon	311.5	Hurricane Creek
Senatobia	4,200	lagoon	1,589.7*	Hickahala Creek
Coldwater** (two plants)	2,000	lagoon	757.0*	Arkabutla Res.

2. Known industrial - None

† Murphy, 1973.
* Estimated at 0.3875 m^3/capita/day.
** Darnell, 1975.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Coldwater River	64,955	49.3
Short Fork Creek	2,335	1.8
Senatobia Creek	3,565	2.7
Senatobia Canal	5,975	4.5
Hickahala Creek	18,890	14.3
Beartail Creek	6,040	4.6
b. Minor tributaries & immediate drainage (non-point load) -	13,010	9.9
c. Known municipal STP's -		
Hernando "A"	7,295	5.5
Hernando "B"	760	0.6
Hernando "C"	970	0.7
Senatobia	4,765	3.6
Coldwater	2,270	1.7
d. Septic tanks* -	25	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	840	0.6
Total	131,695	100.0

2. Outputs -

Lake outlet - Coldwater River 332,675

3. Net annual P loss - 200,980 kg.

* Estimate based on 95 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Coldwater River	569,000	50.7
Short Fork Creek	26,130	2.3
Senatobia Creek	26,195	2.3
Senatobia Canal	74,760	6.6
Hickahala Creek	172,610	15.4
Beartail Creek	52,565	4.7
b. Minor tributaries & immediate drainage (non-point load) -	123,455	11.0
c. Known municipal STP's -		
Hernando "A"	2,170	0.2
Hernando "B"	1,105	0.1
Hernando "C"	1,150	0.1
Senatobia	14,285	1.3
Coldwater	6,800	0.6
d. Septic tanks* -	1,010	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	51,865	4.6
Total	1,123,100	100.0

2. Outputs -

Lake outlet - Coldwater River 1,436,165

3. Net annual N loss - 313,065 kg.

* Estimate based on 95 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg $P/km^2/yr$	kg $N/km^2/yr$
Coldwater River	48	417
Short Fork Creek	58	652
Senatobia Creek	77	568
Senatobia Canal	48	606
Hickahala Creek	32	289
Beartail Creek	50	438

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	2.74	loss*	23.4	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Arkabutla Reservoir:

"Dangerous" (eutrophic loading)	1.06
"Permissible" (oligotrophic loading)	0.53

* There was an apparent loss of both phosphorus and nitrogen during the sampling year. This probably was due to non-representative sampling, especially at the outlet of the reservoir, but may have been due to unknown and unsampled point sources discharging directly to the lake or solubilization of previously sedimented nitrogen and phosphorus.

It appears that the outlet samples were of water leaving the reservoir through an outlet tunnel (Anonymous, 1973); and the water was anaerobic and rich in resolubilized nitrogen and phosphorus.

V. LITERATURE REVIEWED

Anonymous, 1973. Water resources data for Mississippi - 1972. U.S. Geol. Survey, Jackson.

Darnell, Bob (Mayor), 1975. Personal communication (municipal waste facilities at Coldwater). Coldwater.

Murphy, W. Carroll, 1973. Treatment plant questionnaires (Hernando and Senatobia STP's). MS Air & Water Poll. Contr. Comm., Jackson.

Smith, John, 1973. Personal communication (lake morphometry). MS Air & Water Poll. Contr. Comm., Jackson.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

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LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN SD	MEDIAN DISS ORTHO P
2801	ARKABUTLA LAKE	0.194	0.440	465.111	5.500	15.000	0.025
2802	ENID LAKE	0.002	0.240	435.100	6.576	14.900	0.009
2804	ROSS BARNETT RESERVOIR	0.045	0.140	462.917	5.992	14.500	0.008
2805	SARDIS LAKE	0.041	0.190	447.750	5.425	14.500	0.009
2806	GRENADA LAKE	0.051	0.305	476.778	6.022	14.900	0.010

PERCENT OF LAKES WITH HIGHER VALUES (NO. OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500+ MEAN SEC	EPN CHLORA	5+ MIN DO	MEDIAN DISS ORTHO P
2801	ARKABUTLA LAKE	0 (0)	0 (0)	0 (0)	50 (2)	0 (0)	0 (0)
2802	ENID LAKE	25 (1)	50 (2)	50 (2)	25 (1)	38 (1)	63 (2)
2804	ROSS BARNETT RESERVOIR	75 (3)	100 (4)	75 (3)	0 (0)	100 (4)	100 (4)
2805	SARDIS LAKE	100 (4)	75 (3)	100 (4)	75 (3)	75 (3)	63 (2)
2806	GRENADA LAKE	50 (2)	25 (1)	25 (1)	100 (4)	33 (1)	25 (1)

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MISSISSIPPI 02/18/76

LAKE CODE 2801 ARKABUTLA LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 2590.0

NORMALIZED FLOWS(CMS)

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2801A1	1364.9	39.08	50.97	50.12	39.64	20.67	12.74	11.47	6.65	7.08	4.70	18.12	24.92	23.67
2801A2	2590.0	48.22	61.79	71.56	58.81	47.03	32.90	24.75	16.71	15.69	17.24	14.50	34.89	36.88
2801C1	40.1	1.05	1.36	1.33	1.05	0.54	0.28	0.25	0.11	0.11	0.08	0.42	0.68	0.60
2801D1	46.1	1.27	1.64	1.61	1.27	0.51	0.20	0.17	0.06	0.06	0.03	0.37	0.68	0.65
2801E1	169.4	4.87	6.31	6.17	4.87	2.44	1.30	1.16	0.54	0.57	0.34	2.01	3.11	2.79
2801F1	598.3	17.16	22.26	21.97	17.16	8.58	4.13	3.71	1.50	1.67	0.79	6.85	10.99	9.65
2801G1	119.9	3.43	4.50	4.42	3.48	1.73	0.93	0.82	0.40	0.42	0.25	1.44	2.21	1.99
2801ZZ	442.9	12.69	16.54	16.28	12.83	6.60	3.79	3.40	1.81	1.95	1.22	5.61	8.10	7.51

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 2590.0 TOTAL FLOW IN = 566.64
SUM OF SUB-DRAINAGE AREAS = 2781.7 TOTAL FLOW OUT = 444.09

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2801A1	8	73	4.53	22	2.97				
	10	73	7.36	1	2.94	30	3.31		
	12	73	58.90	18	6.80				
	1	74	163.95	5	93.16				
	3	74	27.75	8	11.89				
	4	74	24.35	10	13.03				
	5	74	63.71	14	10.62				
	6	74	78.72	30	9.06				
2801A2	8	73	55.36	22	58.05				
	10	73	26.82	1	16.99	30	11.33		
	12	73	76.91	18	111.85				
	1	74	109.02	5	113.27				
	3	74	59.04	8	72.21				
	4	74	28.40	10	8.50				
	5	74	18.58	14	12.74				
	6	74	26.82	30	50.97				
2801C1	8	73	0.06	22	0.03				
	10	73	0.11	1	0.03	30	0.06		
	12	73	1.59	18	0.11				
	1	74	4.42	5	2.61				
	3	74	0.74	8	0.25				
	4	74	0.65	10	0.31				
	5	74	1.70	14	0.23				
	6	74	2.12	30	0.17				

LAKE CODE 2801 ARKABUTLA LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2801D1	8	73	0.03	22	0.01				
	10	73	0.07	1	0.01	30	0.02		
	12	73	1.87	18	0.06				
	1	74	5.27	5	3.09				
	3	74	0.79	8	0.18				
	4	74	0.68	10	0.21				
	5	74	2.01	14	0.14				
	6	74	2.49	30	0.11				
2801E1	8	73	0.34	22	0.20				
	10	73	0.62	1	0.20	30	0.23		
	12	73	7.33	18	0.54				
	1	74	20.67	5	12.06				
	3	74	3.45	8	1.22				
	4	74	3.03	10	1.39				
	5	74	7.93	14	1.05				
	6	74	9.80	30	0.82				
2801F1	8	73	0.76	22	0.34				
	10	73	1.76	1	0.34	30	0.42		
	12	73	25.74	18	1.56				
	1	74	71.92	5	40.78				
	3	74	12.03	8	3.77				
	4	74	10.62	10	4.39				
	5	74	27.98	14	3.23				
	6	74	34.55	30	2.58				
2801G1	8	73	0.24	22	0.13				
	10	73	0.45	1	0.13	30	0.15		
	12	73	5.18	18	0.40				
	1	74	14.38	5	8.18				
	3	74	2.41	8	0.88				
	4	74	2.12	10	0.99				
	5	74	5.61	14	0.76				
	6	74	6.91	30	0.62				
2801ZZ	8	73	1.22	22	0.76				
	10	73	2.01	1	0.76	30	0.82		
	12	73	18.12	18	1.84				
	1	74	53.24	5	30.30				
	3	74	8.98	8	3.51				
	4	74	7.87	10	3.91				
	5	74	20.67	14	3.11				
	6	74	25.54	30	2.61				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/02/18

280101
34 43 46.0 090 04 56.0 3
ARKABUTLA LAKE
28033 MISSISSIPPI

11EPALES 2111202
0040 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/06/13	15 30	0000	28.5		10	46	8.30J	12	0.160	1.200	0.280	0.021
	15 30	0006	25.4	5.8		50	7.50J	13	0.140	0.500	0.340	0.028
	15 30	0015	21.9	3.8		52	7.10J	13	0.180	0.700	0.500	0.024
	15 30	0026	19.1	0.0		99	7.10J	26	0.660	1.200	0.160	0.029
	15 30	0036	19.0	0.0		100	6.90J	20	0.390	1.000	0.140	0.015
73/08/28	11 15	0000	28.4	5.4	26	70	7.10	24	0.090	1.300	0.100	0.008
	11 15	0005	27.9			71	6.60	25	0.070	0.900	0.070	0.010
	11 15	0015	26.7	2.0		84	6.50	30	0.180	1.100	0.080	0.011
73/11/01	12 37	0000	14.4		8	51	7.90	19	0.140	0.900	0.250	0.026
	12 37	0005	14.4	8.8		52	7.90	19	0.130	0.600	0.250	0.032
	12 37	0015	14.4	9.2		53	7.90	19	0.160	0.800	0.270	0.034

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/06/13	15 30	0000	0.198	7.3
	15 30	0006	0.217	
	15 30	0015	0.252	
	15 30	0026	0.302	
	15 30	0036	0.231	
73/08/28	11 15	0000	0.049	4.1
	11 15	0005	0.048	
	11 15	0015	0.076	
73/11/01	12 37	0000	0.245	10.0
	12 37	0005	0.046	
	12 37	0015	0.411	

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 76/02/18

2H0102
34 45 45.0 090 08 22.0 3
ARKABUTLA LAKE
28033 MISSISSIPPI

11EPALES 2111202
0043 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/06/13	16 10	0000	30.6		10	47	8.30J	15	0.160	0.400	0.300	0.024
	16 10	0006	26.2	6.0		49	7.70J	15	0.170	0.600	0.390	0.030
	16 10	0015	21.2	2.7		56	7.10J	16	0.200	0.600	0.460	0.036
	16 10	0027	19.6	1.8		62	7.10J	18	0.210	0.600	0.390	0.025
	16 10	0039	18.9	0.7		68	7.00J	20	0.320	0.800	0.250	0.019
73/08/28	10 35	0000	29.1	5.2	32	71	7.00	26	0.050	1.000	0.040	0.009
	10 35	0010	28.4	5.4		71	6.70	26	0.070	0.800	0.050	0.009
	10 35	0017	27.3	0.2		74	6.40	26	0.150	1.100	0.070	0.007
	10 35	0027	24.2	0.8		121	6.50	40	0.810	1.900	0.100	0.010
73/11/01	12 52	0000	16.0		12	52	7.90	19	0.110	0.700	0.330	0.030
	12 52	0005	16.0	8.4		52	7.80	19	0.100	0.600	0.330	0.033
	12 52	0010	15.9	8.6		53	7.80	19	0.110	0.500	0.340	0.033
	12 52	0017	15.9	8.8		52	7.70	19	0.100	0.500	0.330	0.029

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/06/13	16 10	0000	0.166	2.9
	16 10	0006	0.231	
	16 10	0015	0.254	
	16 10	0027	0.255	
	16 10	0039	0.227	
73/08/28	10 35	0000	0.058	4.5
	10 35	0010	0.054	
	10 35	0017	0.071	
	10 35	0027	0.110	
73/11/01	12 52	0000	0.185	5.2
	12 52	0005	0.166	
	12 52	0010	0.165	
	12 52	0017	0.165	

STORET RETRIEVAL DATE 76/02/18

280103
34 49 40.0 090 06 10.0 3
ARKABUTLA LAKE
28033 MISSISSIPPI

11EPALES 2111202
0025 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/06/13	17 30	0000	27.4		8	55	7.80J	19	0.250	0.800	0.440	0.029
	17 30	0006	26.7	5.4		55	7.30J	19	0.200	0.500	0.420	0.028
	17 30	0015	22.4	1.6		62	7.10J	18	0.220	0.600	0.360	0.025
	17 30	0021	20.6	0.4		86	6.70J	25	0.370	0.800	0.180	0.020
73/08/28	10 05	0000	29.6	4.4	18	71	6.90	24	0.080	1.400	0.070	0.006
	10 05	0008	28.8	2.8		72	6.50	26	0.110	0.900	0.110	0.008
73/11/01	13 08	0000		9.4	10		7.80	20	0.080	0.900	0.210	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/06/13	17 30	0000	0.227	2.7
	17 30	0006	0.233	
	17 30	0015	0.269	
	17 30	0021	0.334	
73/08/28	10 05	0000	0.065	6.0
	10 05	0008	0.054	
73/11/01	13 08	0000	0.208	15.8

J VALUE KNOWN TO BE IN ERROR

APPENDIX E

TRIBUTARY and WASTEWATER
TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/02/23

2801A1
34 48 02.0 089 53 00.0 4
COLDWATER RIVER
28127 15 HERNANDO
1/ARKABUTLA RES
RD BRDG 4 MI W OF COCKRUM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	11 20		0.130	0.330	0.020	0.038	0.065
73/10/01	14 05		0.168	0.600	0.056	0.029	0.060
73/10/30	09 25		0.088	0.150	0.025		0.065
73/12/18	09 50		0.176	0.100		0.030	0.050
74/01/05	14 20		0.276	0.300	0.030	0.045	0.100
74/03/08	10 25		2.700	0.700	0.040	0.045	0.210
74/04/10	10 30		0.104	0.100	0.090	0.020	0.070
74/05/14	15 45		0.176	0.200	0.025	0.025	0.080
74/06/30	17 00		0.112	0.300	0.010	0.015	0.070

STORET RETRIEVAL DATE 76/02/23

2801A2
34 45 25.0 090 07 30.0 4
COLDWATER RIVER
28 DESOTO MS CO MAP
O/ARKABUTLA RES
SAMPLE FROM DAM IF POSSIBLE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	11 45		0.046	0.540	0.130	0.038	0.120
73/10/01	14 45		0.092	0.600	0.067	0.021	0.145
73/10/30	10 05		0.340	0.750	0.046		0.220
73/12/18	08 30		0.288	1.800	0.525	0.100	0.300
74/01/05	13 30		0.270	0.500	0.085	0.090	0.260
74/03/08	09 35		0.480	1.000	0.075	0.050	0.375
74/04/10	14 20		0.470	0.800	0.060	0.085	0.430
74/05/14	15 00		0.550	1.300	0.065	0.106	0.360
74/06/30	18 00		0.352	0.800	0.060	0.085	0.340

STORET RETRIEVAL DATE 76/02/23

2801C1
34 48 50.0 089 54 30.0 4
SHORT FORK CREEK
28 15 HERNANDO
T/ARKABUTLA RES
RD BRDG 3.5 MI W OF HERNANDO
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	12 00		0.044	1.000	0.033	0.066	0.260
73/10/01	14 10		0.094	1.300	0.030	0.071	
73/10/30	09 30		0.020	0.650	0.036		0.185
73/12/18	10 10		0.440	2.800	0.105	0.060	0.100
74/01/05	14 10		0.470	1.200	0.075	0.040	0.050
74/04/10	14 30		0.024	0.300	0.040	0.040	0.080
74/05/14	15 35		0.028	0.400	0.020	0.040	0.085
74/06/30	18 50		0.028	2.100	0.055	0.055	0.095

STORET RETRIEVAL DATE 76/02/23

2801D1
34 37 10.0 089 56 56.0 4
SENATOBIA, CREEK
28 15 SENATOBIA
T/ARKABUTLA RES
HWY 4 BRDG AT E EDGE OF SENATOBIA
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	10 05		0.028	0.285	0.015	0.027	0.110
73/10/01	13 00		0.140	1.000	0.082	0.189	
73/10/30	08 20		0.048	0.400	0.120		0.095
73/12/18	08 00		0.368	1.700	0.370	0.090	0.220
74/01/05	15 30		0.980	0.200	0.030	0.030	0.080
74/03/08	11 45		0.660	1.200	0.055	0.050	0.260
74/04/10	14 15		0.640	0.700	0.185	0.125	0.220
74/05/14	16 35		0.310	0.900	0.080	0.030	

STORET RETRIEVAL DATE 76/02/23

2801E1
34 37 05.0 089 56 30.0 4
SENATOBIA CANAL
28 15 SENATOBIA
T/ARKABUTLA RES
HWY 4 BRDG .5 MI E OF SENATOBIA
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	10	10	0.026	0.310	0.009	0.017	0.030
73/10/01	13	08	0.110	0.300	0.038	0.013	0.090
73/10/30	08	25	0.270	0.200	0.023		0.020
73/12/18	08	10	0.640	0.500	0.040	0.022	0.035
74/01/05	15	20	1.260	0.500	0.030	0.030	0.050
74/03/08	11	40	0.640	0.300	0.010	0.020	0.170
74/04/10	14	40	0.420	0.400	0.030	0.025	0.055
74/05/14	16	30	0.200	0.500	0.025	0.030	0.075
74/06/30	20	15	0.100	0.700	0.015	0.020	

STORET RETRIEVAL DATE 76/02/23

2801F1
34 37 58.0 089 55 35.0 4
HICHAMALA CREEK
28 15 SENATOBIA
T/ARKABUTLA RES
RD BRDG 1.5 MI NE OF SENATOBIA
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	10	20	0.032	0.310	0.007	0.018	0.035
73/10/01	13	14	0.138	0.300	0.026	0.014	0.085
73/10/30	08	30	0.072	0.625	0.075		0.020
73/12/18	08	20	0.264	0.100K	0.015	0.015	0.030
74/01/05	15	15	0.616	0.200	0.020	0.025	0.045
74/03/08	16	05	0.400	0.700	0.035	0.050	0.180
74/04/10	14	20	0.096	0.400	0.025	0.010	0.010
74/05/14	16	30	0.072	0.100	0.015	0.020	0.055
74/06/30	20	00	0.032	0.400	0.020	0.015	0.080

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/23

2801G1
34 03 35.0 089 53 00.0 4
BEARTAIL CREEK
28 15 SENATOBIA
T/ARKABUTLA RES
RD BRDG 1 MI S OF DANIELS CHAPEL
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/08/22	10 45		0.028	0.290	0.008	0.016	0.040
73/10/01	13 35		0.024	0.800	0.230	0.018	0.130
73/10/30	08 55		0.015	0.100K	0.012		0.020
73/12/18	09 10		0.132	1.000	0.030	0.020	0.035
74/01/05	14 40		0.480	0.200	0.022	0.040	0.075
74/03/08	16 05		0.528	0.950	0.080	0.075	0.260
74/05/14	16 10		0.008	1.000	0.030	0.010	0.090

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/18

2801CA PD2801CA
34 51 30.0 090 00 30.0 4
HERNANDO
28127 15 HORN LAKE
T/ARKABUTLA RES
MUSSACUNA CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/05/01			0.290	5.900	1.890	16.900	18.000		
73/06/01	11 00		0.380	3.150	1.790	14.020		0.020	0.020
73/07/12	10 35		0.046	7.600	5.200	4.800	6.300	0.020	0.020
73/08/24	13 40		0.360	16.000	6.000	8.300	10.000	0.020	0.020
73/11/03	21 45		0.350	8.950	1.380	5.700	7.650	0.020	0.020
74/01/30	13 45		0.840	6.200	0.054		12.000	0.020	0.020
74/04/01	09 00		0.360	1.100	0.170	0.120	0.190	0.200	0.200
74/04/27	09 40		0.400	4.100	3.400	40.000	42.000	0.020	0.020
74/06/03	10 45		0.240	12.000	3.000	14.500	17.000		
74/07/02	11 50		0.280	3.500	0.740	2.500	5.300	1.290	1.290
74/08/02	10 45		0.156	6.000	2.650	23.000	26.000	1.300	1.300

STORET RETRIEVAL DATE 76/02/18

2801CB PD2801CB P000250
34 49 30.0 089 58 00.0 4
HERNANDO
28 15 HERNANDO
T/ARKABUTLA RES
HURRICANE CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/05/01	09	30	0.332	3.650	0.670	2.850	3.300		
73/06/01	10	00	0.070	4.300	1.790	3.400	3.480	0.025	0.025
73/07/12	10	00	0.010K	7.200	0.860	3.990	5.600	0.025	0.025
73/08/24	14	10	0.154	11.500	1.900	7.100	8.800	0.025	0.025
74/01/30	14	45	0.440	9.700	0.430	6.800	8.350	0.025	0.025
74/04/01	10	40	0.200	8.800	2.500	3.000	4.500	0.020	0.020
74/04/27	11	00	0.200	14.000	0.700	4.600	7.400	0.025	0.025
74/05/31	08	00	0.040	15.000	0.600	4.400	6.000		
74/07/02	09	15	0.008	6.550	1.350	3.700	4.500	0.646	0.646
74/08/02	10	15	2.320	7.400	0.350	5.750	6.800		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/18

2801CC PD2801CC P000200
34 49 00.0 090 01 00.0 4
HERNANDO
28 15 HORN LAKE
T/ARKABUTLA RES
HURRICANE CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/05/01	10 00		0.097	12.600	0.330	5.775	7.600		
73/06/01	10 30		0.012	7.900	0.485	6.600	7.500	0.020	0.020
73/07/12	11 00		0.040	11.000	0.335	9.450	11.000	0.020	0.020
73/08/24	14 30		0.150	15.000	0.270	6.100	10.000	0.020	0.020
73/11/03			0.390	11.500	0.790	11.000	14.500	0.020	0.020
74/01/30	14 15		0.680	9.000	0.350	7.000	8.400	0.020	0.020
74/04/01	10 00		0.120	12.000	0.820	7.300	9.800	0.020	0.020
74/04/27	09 55		0.080	10.000	0.370	7.600	9.500	0.020	0.020
74/06/03	09 45		0.040	14.000	2.600	7.800	9.100	0.020	0.020
74/07/02	11 25		0.200	5.500	0.082	5.330	6.200	0.343	0.343
74/08/02	09 45		0.160	14.000	0.460	8.200	10.250	0.320	0.320